The commitment effect of choosing the same bank

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Som-theme F Interactions between consumers and firms

Abstract

In a model where firms use external funds to finance R&D, we show that they may prefer to borrow from the same bank, rather than going to competing banks. A monopolist bank will capture more of the firms' profits. But these profits will also be higher, since having the same bank serves as a commitment device not to spend too much on R&D. In our model, the latter effect dominates.

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1 Introduction

It is generally known that firms are better off when the markets where they obtain their inputs are less concentrated. Less concentration implies more competition, which in turn implies lower input prices. But there may be cases in which firms prefer an input sector that is less competitive. This paper provides such a case. It shows that innovative firms, when choosing at which bank to obtain R&D-financing, may prefer to go to the same bank and, in that way, induce a banking monopoly.

In a nutshell, the argument is as follows. In a Cournot duopoly, innovation is a prisoners' dilemma. For both firms, it is a dominant strategy to do R&D. Yet, when R&D increases a firm's own profits but decreases that of the competitor, both firms would be better off if they could commit to less R&D. Choosing the same bank provides such a commitment device. When a bank decides on granting a loan, it also takes into account the effects on the profits of the other firms it has in its portfolio. A monopolist bank will take the external effects on the profits of other firms into account. It will therefore grant a loan that is lower than the one granted by a bank that serves only one firm in the industry. Firms benefit from this commitment effect of having a monopolist bank. Their profits decrease since the monopolist bank is able to capture more of them, but increase because of the commitment effect. In our model, the latter effect dominates.

We model the above intuition with a model based on d'Aspremont and Jacquemin (1988). In their model, spending on R&D implies that the marginal costs of a firm will be lowered with certainty. The higher the amount spent on R&D, the higher the decrease in cost. Yet, d'Aspremont and Jacquemin (1988) assume that firms can self-finance their R&D. We assume that firms possess no wealth, and have to take a loan to do R&D. Another related paper is Brander and Lewis (1986). They also study the strategic effect of debt, albeit in an entirely different context. Their model has uncertainty, and taking on debt effectively shifts some of the risk to the lender, making the firms more aggressive competitors. In our model, debt also makes firms more aggressive, but only because it allows firms to spend more on R&D. Also, in Brander and Lewis (1986) the financial market, e.g. banks, acts passively. Banks do not take into account the product market behavior in the determination of the loan size and the required repayment. In our model, it is exactly the bank that decides on these issues, which in turn allows firms to use their bank relationship as a strategic device.

In a sense, the equilibrium of our model with a monopolist bank exhibits credit rationing. With a monopolist bank, each firm unilaterally wants to obtain a higher loan than the one offered by the bank. Doing so enables it to spend more on R&D, raising its profits, to the detriment of its competitor. Yet, the bank is not willing to give a higher loan, since it also takes the effects on the competitor's profits into account. Firms are thus credit rationed, albeit in a different sense than they are in the traditional asymmetric information models of credit markets (see e.g. Stiglitz and Weiss 1981). Credit rationing in our model more closely resembles that in Clemenz (1991), who also notes that lenders have an incentive to take the complementarity of loans into account. Paradoxically, in our model, firms *choose* to be credit rationed. By choosing the same bank from the outset, firms commit not to do too much R&D. Hence, they rationally choose to be credit rationed.

The remainder of this paper is structured as follows. The benchmark model is described in section 2. In section 3 we derive the contracts offered by a monopolist bank. Section 4 considers the case in which both firms choose to go to a different bank. Section 5 compares the two outcomes from the point of view of the firms, and shows that firms prefer to choose to go to the same bank. The analysis may suggest that firms always prefer a more concentrated market structure in banking. This, however, is not the case. When the banks also have access to a perfectly competitive credit market, they prefer to go there, rather than to a monopolist bank. This is shown in section 6. Often, however, firms will not have the option to go to a perfectly competitive credit market, particularly if they are locked in with the relationship they have with their current bank, or when a competitive credit market simply does not exist. Section 7 concludes.

2 Set-up of the model

The basic setup of our model is the following. There are two firms, 1 and 2. We have three stages. In the first stage, firms can choose which bank to do business with. They can choose to go to the same bank, or they can choose different banks. There are several ways to implement this stage. We can assume that firms choose their bank sequentially, and that the second firm can observe the choice of the first firm. Alternatively, we may simply assume that the firms cooperate in their choice of bank. In the end, this does not matter, since there is no first mover advantage or disadvantage in choosing a bank. We assume that, once a firm has chosen its bank, it is locked in. Banks obtain a lot of private information in their relationship with a firm. Only when possessing this private information, they are able to fully evaluate its prospects and credibility. Therefore, when needing a loan, a firm is not able to go to a different bank. Effectively, it is locked in, and the bank has all the bargaining power. Essentially, we assume that a firm initially has to choose a bank to do all of its business with. Then, when it wants to obtain a loan, it is stuck with this bank.

In the second stage, the level of R&D for each firm is determined. Without any spending on R&D, a firm's marginal cost equals c. However, by spending $\frac{1}{2}\gamma x_i^2$ on R&D now, marginal cost of firm i $(i = 1, 2)$ will be reduced by an amount $\Delta c_i = x_i$ in the next stage. We assume that firms do not have funds to finance their R&D, and have to obtain a loan to do so. In the third stage, firms compete in quantities on the output market. Inverse demand for this market is given by $p = a - Q$ where p denotes market price and $Q = q_1 + q_2$ refers to total quantity. After stage 3, firms repay their loan according to the specification of their loan contract. We assume that banks can always force a firm to pay its debt. Since there is no uncertainty in our model, non-payment is not an issue. Note that, from stage 2 onwards, our model resembles d'Aspremont and Jacquemin (1988). Yet, we assume that firms cannot finance their own R&D, and have to resort to a loan. Also, we abstract from R&D spillovers, which would merely complicate our analysis without adding substantial insight.

We solve the model using backward induction. In the final stage, firms compete à la Cournot. Firm i's Cournot profits then equal

$$\pi_i = (p - c + x_i)\, q_i. \tag{1}$$

The optimal quantities are

$$q_i = (a - c + 2x_i - x_j)/3, \tag{2}$$

yielding profits

$$\pi_i(x_i, x_j) = \frac{1}{9}(a - c + 2x_i - x_j)^2. \tag{3}$$

We can now move to stage two. In this stage, there are two possible subgames. In the first subgame, both firms choose to go to the same bank. This subgame is studied in section 3. In the other subgame, firms choose to go to a different bank. Note that, in that case, firms are still locked in with their bank once they apply for a loan. Therefore, we refer to this case as one with two local monopolies. We study this case in section 4.

3 A monopolist bank

3.1 Introduction

We first consider the subgame in which firms obtain loans from one single bank. The timing of the contracting stage is as follows. First, the bank offers a loan contract to both firms. Such a contract specifies a loan size and a required repayment. Firms then decide whether to accept or reject the contract. When a firm accepts the contract, it can decide how much money to spend on R&D, which is constrained by the loan it has obtained. If the firm rejects the loan, it cannot do R&D. Finally, firms compete Cournot, and repay the bank. Note that the assumption that the bank has all bargaining power implies that it decides on the size of the loan. The firm is simply stuck with the bank's take-it-or-leave-it loan offer, and cannot obtain any other loan. We will see that in the equilibrium in which both firms are offered a contract, the firm would like to have more funds, and do more R&D. Yet, the bank will not grant such a higher loan and, effectively, the firm faces a credit constraint.

Consider firm 1. By accepting the loan of size L_1, with corresponding repayment (interest and principal) equal to R_1, its net profits will equal

$$\Pi_1(x_1, x_2, L_1, R_1) = \pi_1(x_1, x_2) - \frac{1}{2}\gamma x_1^2 + L_1 - R_1 \tag{4}$$

We assume that a bank can control how a firm spends the loan, that is, we assume that the entire loan will be spent on R&D. Hence

$$x_i = \sqrt{2L_i/\gamma}, \tag{5}$$

so

$$\Pi_1(x_1, x_2, R_1) = \pi_1(x_1, x_2) - R_1. \tag{6}$$

For expositional convenience, we will express a firm's net profits in terms of loan size rather than cost reduction, and write

$$\Pi_1(L_1, L_2, R_1) = \pi_1(L_1, L_2) - R_1. \tag{7}$$

We have four different possible outcomes depending on whether or not firms accept the loan. Let's denote the corresponding profits by $\pi_i(L_1, L_2)$, $\pi_i(0, L_2)$, $\pi_i(L_1, 0)$, and $\pi_i(0, 0)$. For our analysis, we need the following assumption to be satisfied.

Assumption 1 *The functions $\pi_1(L_1, L_2)$ and $\pi_2(L_1, L_2)$ are strictly submodular.*

Thus

$$\pi_1(L_1, L_2) - \pi_1(l_1, L_2) < \pi_1(L_1, l_2) - \pi_1(l_1, l_2) \tag{8}$$

$$\pi_2(L_1, L_2) - \pi_2(L_1, l_2) < \pi_2(l_1, L_2) - \pi_2(l_1, l_2), \tag{9}$$

for all $L_1 > l_1$, $L_2 > l_2$. Note that this implies that profits π_1 and π_2 have decreasing differences in (L_1, L_2), which in turn implies that the increment in operating profits from accepting the loan is smaller if the other firm accepts its loan than when it rejects its loan. In our model, with Cournot competition, this is always satisfied. For more on supermodularity, see e.g Gans (1996), Milgrom and Shannon (1994), or Milgrom and Roberts (1994).

Suppose the bank offers the contract (L_1, R_1) to firm 1 and (L_2, R_2) to firm 2, where L denotes the loan size, and R the required repayment. We solve by backward induction and first consider the equilibrium in the loan acceptance subgame. There, payoffs are as follows

<table>
<tr><td></td><td></td><td colspan="2">Firm 2</td></tr>
<tr><td></td><td></td><td>Accept</td><td>Reject</td></tr>
<tr><td rowspan="2">Firm 1</td><td>Accept</td><td>$\pi_1(L_1, L_2) - R_1$
$\pi_2(L_1, L_2) - R_2$</td><td>$\pi_1(L_1, 0) - R_1$
$\pi_2(L_1, 0)$</td></tr>
<tr><td>Reject</td><td>$\pi_1(0, L_2)$
$\pi_2(0, L_2) - R_2$</td><td>$\pi_1(0, 0)$
$\pi_2(0, 0)$</td></tr>
</table>

Table 1: Payoffs to the firms in the loan acceptance subgame.

Denote the strategies as A and R. Note that the Nash equilibrium for this subgame depends on the sizes of loans and repayments. Consider firm 1. For accepting to be a (weakly) dominant strategy we need

$$R_1 \leq \pi_1(L_1, L_2) - \pi_1(0, L_2) \tag{10}$$

and

$$R_1 \leq \pi_1(L_1, 0) - \pi_1(0, 0). \tag{11}$$

Using assumption 1, note that condition (10) is sufficient for (11) to be satisfied. Thus, given L_1 and L_2, the bank has three possibilities in choosing R_1. It can set

R_1 such that neither condition is satisfied, such that both conditions are satisfied, or such that only condition (11) is satisfied. For firm 2, a similar analysis holds, where the relevant conditions are given by

$$R_2 \leq \pi_2(L_1, L_2) - \pi_2(L_1, 0) \tag{12}$$

$$R_2 \leq \pi_2(0, L_2) - \pi_2(0, 0). \tag{13}$$

The following table gives all pure strategy Nash equilibria for each of the resulting nine cases, where, for example (A,R) denotes an equilibrium in which firm 1 accepts, and firm 2 rejects. In the remainder, we will restrict attention to pure strategy equilibria.

Assumption 1 allows us to explain precisely the above bank's strategies. Take for example expression (8). Here the bank can set R_1 such that it is on the left side, or in the middle, or in the right side of this expression. If R_1 is set on the left side, then it is optimal for the bank to set $R_1 = \pi_1 (L_1, L_2) - \pi_1 (l_1, L_2)$, thus making expression (10) holds with equality. For R_1 below this, it is possible for the bank to increase R_1 without inducing firm 1 to reject the loan. When R_1 is set in the middle, then it is optimal for the bank to set $R_1 = \pi_1(L_1, l_2) - \pi_1(l_1, l_2)$, thus making expression (11) holds with equality. The same analysis applies for setting R_2. The main idea here is that the bank can induce any outcome. The choice will depend on the magnitude of profits under different strategies. There are 4 candidates of equilibria, these are the four bold pairs in Table 2.

The bold pairs located in the middle of Table 2 represents a coordination problem. Suppose that the bank initially sets R_1 such that both conditions for both firms are satisfied. Then the outcome is (A,A). Here, the bank may be better off (for certain values of $(1 + r)\gamma$) by doing the followings policies. The bank can increase R_1 such that expression (11) holds with equality and increase R_2 such that neither condition for firm 2 is satisfied. Firm 2 will then reject the loan, while firm 1 will accept the loan eventhough firm 1 will have to pay a higher R_1 than before. The fact that firm 2 rejects the loan is beneficial for firm 1, because the reduction of profits due to the higher R_1 is more than compensated by the increase in profits due to the fact that firm 2 rejects the loan. This is nothing else then our supermodularity (submodularity) assumption, which says that the increment in operating profits from accepting the loan is smaller if the other firm accepts its loan than when it rejects its loan). The outcome of this bank's strategy is (A,R).

Alternatively, the bank can also induce the mirror image of (A,R), i.e. (R,A). Finally, the bank can also choose to induce the middle outcome where the coordination problem arises. If the bank indeed does this, then this outcome is an equilibrium, because the bank can do no better.

		Bank neither	only (13)	both
	neither	(R,R)	**(R,A)**	(R,A)
Bank	only (11)	**(A,R)**	**(A,R); (R,A)**	(R,A)
	both	(A,R)	(A,R)	**(A,A)**

Table 2: Pure strategy Nash equilibria in the loan acceptance subgame.

Note that, ceteris paribus, the bank always prefers a higher repayment. In the table above, R_2 is higher as we move to the left. Similarly, R_1 is higher as we move up. Thus, given some equilibrium outcome in this subgame, in general the bank always prefers a case that is more to the northwest in table 2. Also note that inducing (R,R) yields zero profits for the bank. It is easy to see that the bank can earn strictly positive profits by following a different strategy. We restrict attention to three cases, i.e. the case in which both conditions are satisfied for both firms, the case in which neither condition is satisfied for firm 2, and only (11) holds for firm 1, and the case in which neither condition is satisfied for firm 1, and only (13) holds for firm 2. Note that from the calculation point of view, the case with coordination problem gives an equivalent outcome to the second case we consider. We analyse the three cases in turn.

3.2 Offering both firms a contract

First consider the case in which the contract is designed such that both firms accept, which is the case (A,A) in table 2. Note that offering a firm a contract that will be rejected is equivalent to offering no contract to that firm. Hence, we restrict attention to $L_1, L_2 > 0$. Conditional on acceptance, it is profit-maximizing for the bank to set

$$R_1 = \pi_1(L_1, L_2) - \pi_1(0, L_2) \tag{14}$$

and

$$R_2 = \pi_2(L_1, L_2) - \pi_2(L_1, 0). \tag{15}$$

The bank's profits are

$$\pi_B = R_1 + R_2 - (1+r)(L_1 + L_2). \tag{16}$$

The first two terms give the gross revenue from lending, the last term the costs to the bank of obtaining loanable funds. From (14) and (15),

$$\pi_B = \pi_1(L_1, L_2) - \pi_1(0, L_2) + \pi_2(L_1, L_2) - \pi_2(L_1, 0) - (1+r)(L_1 + L_2). \tag{17}$$

Using (5), we can maximize over xs rather than Ls. Substituting from (3) and (5), we have FOCs

$$\frac{4}{9}a - \frac{4}{9}c + \frac{8}{9}x_1 - \frac{8}{9}x_2 - (1+r)\gamma x_1 = 0, \tag{18}$$

$$\frac{4}{9}a - \frac{4}{9}c + \frac{8}{9}x_2 - \frac{8}{9}x_1 - (1+r)\gamma x_2 = 0. \tag{19}$$

The Hessian is

$$\mathbf{H} = \begin{pmatrix} \frac{8}{9} - \gamma(1+r) & -\frac{8}{9} \\ -\frac{8}{9} & \frac{8}{9} - \gamma(1+r) \end{pmatrix}. \tag{20}$$

For a maximum, we need $\gamma(1+r) > 8/9$ and, moreover $|\mathbf{H}| > 0$, thus $\gamma(1+r) > 16/9$. Using the FOCs, we have that the monopolist sets

$$x_1^m = x_2^m = x^m = \frac{4}{9}\frac{a-c}{\gamma(1+r)}, \tag{21}$$

as long as $\gamma(1+r) > 16/9$. In this symmetric equilibrium, the bank's profits are:

$$\pi_B^m = \frac{16}{81}\frac{(a-c)^2}{\gamma(1+r)}, \tag{22}$$

whereas the profits of both firms equal

$$\begin{aligned}\pi^m &= \pi_1(x^m, x^m) - R_1 = \pi_1(0, x^m) && (23)\\ &= \frac{1}{729}(a-c)^2\left(\frac{9\gamma(1+r)-4}{\gamma(1+r)}\right)^2. && (24)\end{aligned}$$

3.3 Offering a single contract

3.3.1 Introduction

Now consider the case in which one firm accepts the contract while the other firm rejects, i.e. either the second case (A,R) or the third case (R,A). These cases are mirror images, thus we can concentrate on the second case. Note that rejecting a contract is equivalent to accepting a contract with zero loan. Therefore, we consider the case (A,R) in which the bank offers a zero contract to firm 2. The bank can now set

$$R = \pi_1(L_1, 0) - \pi_1(0, 0), \tag{25}$$

There are two possibilities. First, the bank may offer firm 1 a small loan such that, when firm 1 accepts, firm 2 still produces positive output in the Cournot equilibrium. Second, the bank may offer firm 1 a contract that allows it to do so much innovation that firm 2 is no longer able to compete against firm 1. In other words, the bank may offer firm 1 a contract that allows it to do a drastic innovation in the sense of Arrow (1962). In a Cournot equilibrium, firm 2 will set

$$q_2 = (a - c - x_1)/3. \tag{26}$$

This is not feasible if $a - c - x_1 < 0$, hence if $x_1 > a - c$. Thus, if that is the case, we have a drastic innovation and firm 1 becomes a monopolist. Otherwise, we still have a Cournot duopoly. We consider these two cases in turn.

3.3.2 Optimization conditional on a duopoly

First suppose the bank wants to induce a duopoly. He then faces the constraint $x_1 < a - c$. In this case, we have

$$\pi_1(L_1, 0) = (a - c + 2x_1)^2/9. \tag{27}$$

Profits of the bank thus equal

$$\pi_B = \pi_1(L_1, 0) - \pi_1(0, 0) - (1 + r)\gamma x_1^2/2. \tag{28}$$

Note that the term $\pi_1(0, 0)$ does not depend on L_1 and therefore does not affect the optimization problem. We have

$$\pi_B = (a - c + 2x_1)^2/9 - \pi_1(0, 0) - (1 + r)\gamma x_1^2/2. \tag{29}$$

Taking the FOC yields

$$x_1 = \frac{4(a - c)}{9\gamma(1 + r) - 8}. \tag{30}$$

For this to be in the admissible interval, we need it to be smaller than $a - c$. That yields $\gamma(1 + r) \geq 3/4$, but that is always satisfied since $\gamma(1 + r) > 8/9$. Firm's gross profits now equal

$$\pi_1(L_1, 0) = \left(\frac{3\gamma\,(1 + r)\,(a - c)}{(9\gamma\,(1 + r) - 8)}\right)^2, \tag{31}$$

so the bank's profits are

$$\pi^B = \frac{8}{9}\frac{(a - c)^2}{9\gamma\,(1 + r) - 8}. \tag{32}$$

The firm is left with its outside option

$$\pi = (a - c)^2/9. \tag{33}$$

3.3.3 Optimization conditional on a monopoly

Now the relevant interval is $x_1 > a - c$, and

$$\pi_1(L_1, 0) = (a - c + x_1)^2/4. \tag{34}$$

Profits of the bank thus equal

$$\pi_B = (a - c + x_1)^2/4 - \pi_1(0,0) - (1+r)\gamma x_1^2/2. \tag{35}$$

Taking the FOC

$$x_1 = \frac{a-c}{2(1+r)\gamma - 1}. \tag{36}$$

This needs to be larger than $a - c$, which implies $(1+r)\gamma \leq 1$. If that is not the case, the best the bank can do is the constrained optimum $x = a - c$. The unconstrained optimum yields

$$\pi_1(L_1, 0) = \left(\frac{\gamma(1+r)(a-c)}{2\gamma(1+r) - 1}\right)^2, \tag{37}$$

thus bank profits are

$$\pi^B = \frac{1}{18}(a-c)^2 \frac{5\gamma(1+r) + 2}{2\gamma(1+r) - 1}. \tag{38}$$

The constrained optimum has

$$\pi_1(L_1, 0) = (a-c)^2, \tag{39}$$

yielding bank profits

$$\pi^B = \left(\frac{8}{9} - \gamma(1+r)\right)(a-c)^2, \tag{40}$$

but with $\gamma(1+r) > 1$, this yields negative profits, which cannot be an equilibrium.

3.3.4 Wrapping up

From the analyses above, we thus have that offering one contract that induces a duopoly is always feasible and profitable. Offering one contract that induces a monopoly is only feasible and profitable with $\gamma(1+r) \leq 1$. Thus, when only offering one contract, the bank always chooses to induce a duopoly with $\gamma(1+r) > 1$. With $8/9 < \gamma(1+r) \leq 1$, we have to compare profits. But is easy to see that, also in that interval, the bank prefers a duopoly over a monopoly.

3.4 Comparing outcomes: The equilibrium contract

In the previous subsections we described two possible outcomes of this subgame: the monopolist bank offers the same contract to both firms, or offers just one contract such that there is a product market duopoly. Figure 1 gives the profits to the bank of each of these options, where the profit functions are as derived in the previous subsections. In the figure we have, for simplicity, set $(a-c)$ equal to 1. Since the expression $(a-c)^2$ is present in every profit function, its actual value drops out when comparing profits. With $8/9 < \gamma < 16/9$, the bank will offer just one contract. With $\gamma > 16/9$, it is profit maximizing to offer a contract to both firms.

— INSERT FIGURE 1 ABOUT HERE —

4 Two local bank monopolies

Now, we analyze the case in which firms choose to go to different banks, and each bank serves a single client only. We refer to this case as a local monopoly in the banking market. In the second stage, the two firms compete and maximize profits by choosing quantities q_1 and q_2, respectively, taking x_1 and x_2 as given. Conceptually, the game is identical to that in table 1, the only difference being that the contracts (L_i, R_i) are now offered by two different banks. This implies that we can restrict attention to the case in which both firms will accept their contract.

Bank 1 can now set

$$R_1 = \pi_1(L_1, L_2) - \pi_1(0, L_2), \tag{41}$$

given the loan L_2 offered by bank 2 to firm 2. This yields profits

$$\begin{aligned} \pi_{B1} &= \pi_1(L_1, L_2) - \pi_1(0, L_2) - (1+r)L_1 & (42) \\ &= (a - c + 2x_1 - x_2)^2/9 - (a - c - x_2)^2/9 - \gamma(1+r)\, x_1^2/2 & (43) \\ &= \frac{4}{9} x_1 (a - c + x_1 - x_2) - \gamma(1+r)\, x_1^2/2. & (44) \end{aligned}$$

Simultaneously, bank 2 profits are given by

$$\pi_{B2} = \frac{4}{9} x_2 (a - c + x_2 - x_1) - \gamma(1+r)\, x_2^2/2. \tag{45}$$

The FOCs are

$$\begin{aligned} \frac{4}{9}(a - c + 2x_1 - x_2) - \gamma(1+r)\, x_1 &= 0. & (46) \\ \frac{4}{9}(a - c + 2x_2 - x_1) - \gamma(1+r)\, x_2 &= 0. & (47) \end{aligned}$$

Solving simultaneously yields a unique symmetric solution $x_1 = x_2 = x$, with

$$x = \frac{4(a-c)}{9\gamma(1+r) - 4}. \tag{48}$$

The SOCs again require $\gamma(1+r) > 8/9$. Plugging this into (45), equilibrium bank profits equal

$$\pi_B^d = \frac{8}{9}(a-c)^2 \frac{9\gamma(1+r) - 8}{(9\gamma(1+r) - 4)^2} \tag{49}$$

whereas firm profits equal

$$\begin{aligned} \pi_i^d &= \pi(x, x) - R = \pi(0, x) & (50) \\ &= \frac{1}{9}(a - c - x)^2 & (51) \\ &= \frac{1}{9}(a-c)^2 \left(\frac{9\gamma(1+r) - 8}{9\gamma(1+r) - 4}\right)^2 & (52) \end{aligned}$$

It can be shown that, in the first stage, the banks' problem is equivalent to that of the firms in the case they can finance their own R&D (see section 6). In both cases, the amount of R&D is set to maximize π_1, taken the R&D decision of the competitor as given. Therefore, the equilibrium x in this model is identical to one in a model with self-financing. Therefore, the sum of profits of bank and firm in this model, equals the profits of the firm in a model of self-financing. Only the distribution of profits is different. Hence, two local monopolist banks face the same problem as two firms who can self-finance their R&D. Both are inclined to set a level of R&D that is too high, since they do not take the negative effect on the competitor's profits into account.

5 The commitment effect of credit rationing

We now move to the first stage, in which firms choose their bank. For example, one may assume that firm 1 first chooses a bank to have a relationship with, and after that, firm 2 chooses its bank. Only after both have chosen their bank, the firms decide on R&D and go to their respective banks to try to obtain a loan. Effectively, the firms can thus choose between two scenarios: the one with a global bank monopoly, described in section 3, and the one with two local bank monopolies, described in section 4. Note that, in the case of choosing the same bank, for any $\gamma > 8/9$, the profits of the firms equals at least the expression given by (24): with $\gamma \in (8/9, 16/9)$, firm profits are given by, (33), which are higher. Yet, it can easily be shown that the profits given by (**??**) are always higher than those given by (49), which are the firm profits in the case they choose different banks. We thus have our main result:

Result 1 *Firms always prefer to go to the same bank rather than being locked in by two different banks.*

The intuition for this result is as follows. Suppose firms finance their R&D out of their own pocket. Each firm has a unilateral incentive to do R&D: an increase in R&D increases a firm's own profits, but lowers the profits of the competitor. Yet, the same holds for the other firm. Each firm individually has an incentive to do R&D, but if both do R&D, then in equilibrium industry profits are lower than they are in a case without R&D. Therefore, the firms have an incentive to commit not to do too much R&D. One way to make such commitment is, when self-financing of R&D is not feasible, to go to the same bank to obtain a loan. When deciding on the loans to offer to both firms, a monopolist bank internalizes the external effects R&D has on the profits of the other firm. Hence, the total amount of R&D is lower with a monopoly bank than it is when firms go to different banks. The downside is that a monopolist bank is also able to capture more of the profits. Indeed, it can be shown that total bank profits are higher in the global monopoly case than they are in the local monopoly case. Nevertheless, the commitment effect dominates.

6 Extension: A competitive credit market

In the above analysis we showed that a product market duopoly may prefer a case in which the banking sector is more concentrated. In this section, however, we show that this is not always the case. We do so by analyzing the case of a perfectly competitive product market, and show that the firms often prefer such a market over that of a global monopolist bank.

Note that when considering a perfectly competitive credit market, we explicitly have to drop the assumption that the firm is locked in with the bank it is currently doing business with. The firm can now obtain any amount of funds at a constant rate of r. The costs of doing R&D therefore equal $\frac{1}{2}\gamma(1+r)x_i^2$. In stage 1, and given the outcome of stage 2 a firm maximizes operating profits

$$\Pi_i = \pi_i - \frac{1}{2}\gamma(1+r)x_i^2. \tag{53}$$

Maximizing this expression yields a best response

$$x_i = 4\frac{a-c-x_j}{9\gamma(1+r)-8}. \tag{54}$$

Solving for the equilibrium R&D, we have that both firms set x equal to

$$x^C = \frac{4(a-c)}{9\gamma(1+r)-4}. \tag{55}$$

Again, the second order conditions require

$$\gamma(1+r) > 8/9 \tag{56}$$

as a necessary condition for an equilibrium with positive R&D expenditures. Plugging (55) back into (53) yields operating equilibrium profits

$$\begin{aligned} \Pi^C &= (a-c+x)^2/9 - \gamma(1+r)x^2/2 && (57) \\ &= \gamma(1+r)(a-c)^2 \frac{9\gamma(1+r)-8}{(9\gamma(1+r)-4)^2} && (58) \end{aligned}$$

Note that this equals the *full* profits (that is, the sum of profits of a firm and its bank) in the case that there are two local monopolist banks. This is intuitive: the optimal amount of R&D set by the firms in this case equals the amount in these case when firms can self-finance their R&D, which in turn equals the amount of R&D they set when there are two local monopolist banks. The only difference is the distribution of profits. With self-financing and with a perfectly competitive credit market, firms take all of the profits.

Compared to the case of a global monopolist bank, it can be shown that the firms always prefer a perfectly competitive credit market as long as the equilibrium in the global monopoly case implies that both are being offered a contract. In that case, $\gamma(1+r)$ is relatively high, so the level of x is relatively low, implying that the commitment effect is small. When only one firm is offered a contract, expected profits may be higher with a global monopolist than they are with a perfectly competitive credit market. There is still a commitment effect of going to a monopolist bank. Although firms do like this commitment effect, the price in terms of lost profits is simply too high compared to the case of a competitive credit market. Hence, it is not true that firms always prefer a more concentrated market structure in banking.

7 Conclusion

In this paper we presented a three-stage model in which firms obtain external funds to invest in R&D. They first choose whether to go to the same bank, or to go to two different banks. Once they have chosen a bank, they are locked in. In the next stage, the level of R&D is determined. Finally, firms compete in quantities à la Cournot. We showed that firms always prefer to go to the same bank. Such a monopolist bank will capture more of the firm's profits. But these profits will also be higher, since going to the same bank serves as a commitment effect not to spend too much on R&D. In the end, the latter effect dominates, and firms are better off choosing the same bank. This does not imply, however, that firms in our model always prefer a more concentrated credit market structure. When a perfectly competitive credit market is feasible, firms would often prefer to go there, rather than to a monopolistic bank.

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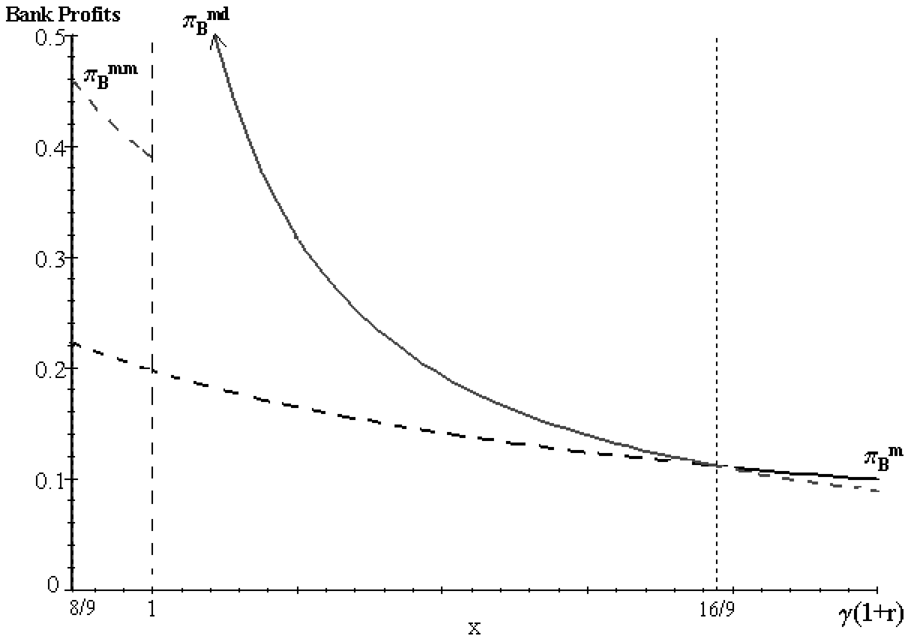
Figure 1.



Bank Profits
0.5
0.4
0.3
0.2
0.1
0
π_B^{md}
π_B^{mm}
π_B^{m}
8/9
1
16/9
x
$\gamma(1+r)$